# A New Family of Poecilostomatoid Copepods (Umazuracolidae) Based on Specimens Parasitic on the Black Scraper (*Thamnaconus modestus*) in Japan

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*Umazuracola elongatus* n. gen., n. sp., is described based on specimens collected from the body surface of the black scraper, *Thamnaconus modestus* (Günther), taken from the Seto Inland Sea in western Japan. The new species belongs to a new family of the copepod order Poecilostomatoida. It is characterised by the reduction of the maxilliped and leg 1 in females and modification in both sexes of legs 2, 3, and 4 into robust attachment organs, with heavy, denticulate outer spines. Although the antenna, mandible, maxillule, and maxilla of *U. elongatus* resemble those of species of the "bomolochiform complex", a cladistic analysis revealed that phylogenetically this species is embedded in a different clade containing the polychaete-parasitizing families Entobiidae Ho, 1984 and Nereicolidae Claus, 1875.

**Key words:** parasitic copepods, Poecilostomatoida, Umazuracolidae, black scraper

## INTRODUCTION

The copepod order Poecilostomatoida comprises mostly symbiotic members, with only a few species being planktonic (Ho, 1991; Huys and Boxshall, 1991). Recently, because of concern over inadequate knowledge of the phylogenetic relationships between the copepod orders Cyclopoida and Poecilostomatoida, Boxshall and Halsey (2004: p. 41) merged all families of Poecilostomatoida into the Cyclopoida. Traditionally, these orders have been clearly distinguished by (1) the number of segments on the antennule, (2) the structure of the maxillipeds of both sexes, (3) the location of female genital apertures, and (4) the presence or absence of geniculation in the male antennule. Therefore, we here retain the traditional concept of the Poecilostomatoida, which was established by Thorell (1859). Since cyclopoid classification is still in a state of flux, the arbitrary merging of poecilostomatoid families into Cyclopoida without rigorous phylogenetic support is not justified.

During our survey of parasitic copepods in East Asia, an undescribed species of the Poecilostomatoida was found parasitic on the body surface of black scrapers, *Thamnaconus modestus* (Günther), caught in the Seto Inland Sea of western Japan in August 2003 and May 2005. As far as we are aware, there is only one record of a previous species of poecilostomatoid copepod, *Taeniacanthus balistae* (Claus, 1864), parasitic on a fish of this species taken from the same sea. Yamaguti and Yamasu (1959) and Shiino (1960) reported this parasite as "*Taeniacanthus longichela* Yamaguti and Yamasu, 1959" parasitic on "*Cantherhines modestus* (Günther)." A close examination of our new species indicated that it belongs to a new family of the Poecilostomatoida. In this paper, we report the results of a cladistic analysis conducted to determine the phylogenetic position of the new family, and we also describe the new species.

## MATERIALS AND METHODS

Copepod parasites were removed from the body surface of black scrapers (*Thamnaconus modestus*; total length 236–300 mm) and preserved in 70% ethanol. The specimens were later soaked in 85% lactic acid for a few hours before dissection under a stereoscopic microscope. Following the method of Humes and Gooding (1964), removed appendages and body parts were examined under a microscope with differential interference contrast (Nikon Optiphoto). Two specimens collected on 1 August 2003 were dehydrated in alcohol-series, sputter-coated, and examined with a scanning electron microscope (Jeol T-20).

A cladistic analysis of the order Poecilostomatoida was conducted by Ho (1991) to determine the phylogenetic relationships among the 47 families then known. However, the order now comprises 61 families (Martin and Davis, 2001); thus, the cladistic analysis needed to be performed anew. In total, we utilized 138 morphological characters (Appendix 1) in a new analysis, all of them encoded in binary states. Our data matrix of the 138 characters and their states in the 61 poecilostome families is given in Appendix 2. As in Ho's (1991) previous analysis, the family Cyclopinidae was used as a outgroup. An unordered transformation of character states was also employed, to avoid an *a priori* predetermination of the topology of the resultant cladogram. The phylogenetic analysis was performed with HENNIG86 Version 1.5 software (Farris, 1988),

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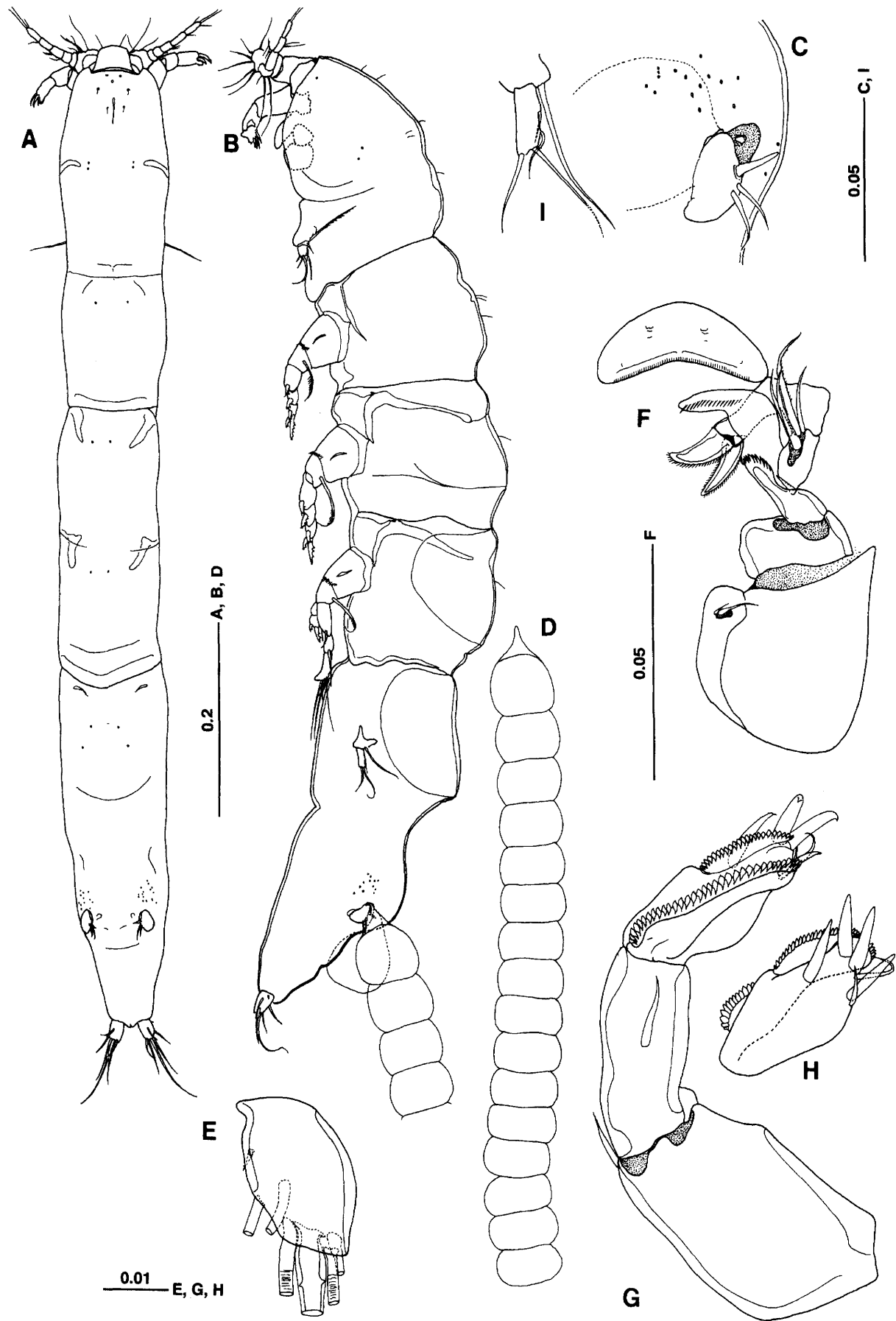
**Fig. 1.** *Umazuracola elongatus* n. g., n. sp., female (A, C, F–I, paratypes; B, D, E, holotype). **A,** habitus, dorsal. **B,** habitus, lateral. **C,** genital area and leg 6. **D,** egg sac. **E,** caudal ramus, ventral. **F,** labrum and oral appendages. **G,** antenna. **H,** endopod of antenna. **I,** leg 5, anterior. Scales in millimeters.

using the commands "mhennig" and "bb". The first command constructs several initial trees and saves only one shortest tree after limited branch-swapping; the second performs extended branch swapping on this initial cladgram to produce multiple, shortest trees.

A total of 100 trees were produced.

Terminology used in this paper follows Huys and Boxshall (1991). Type specimens have been deposited in the Kitakyushu Museum of Natural History and Human History (KMNH IvR).
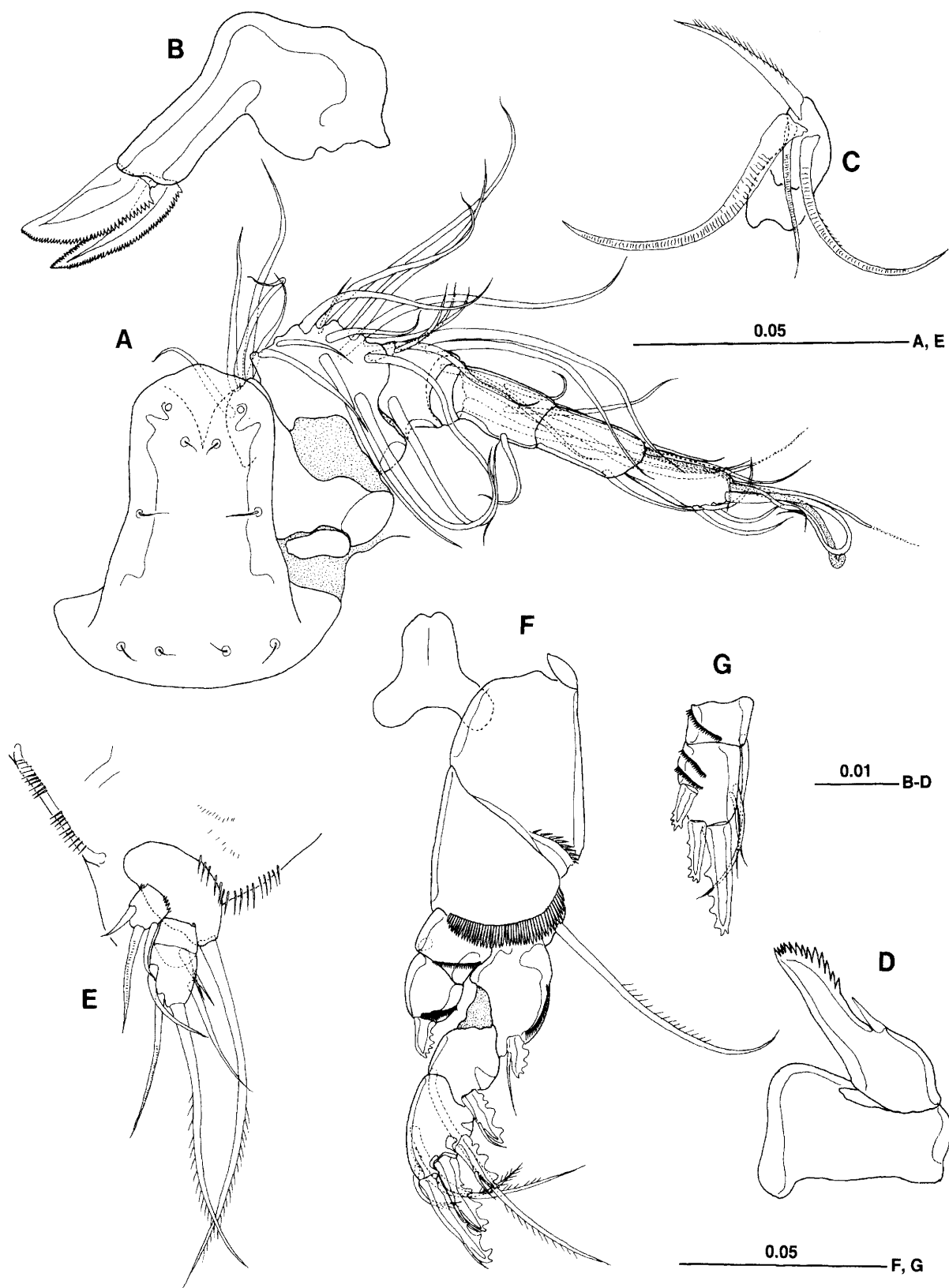


**Fig. 2.** *Umazuracola elongatus* n. g., n. sp., female (A–E, paratype; F, G, holotype). **A,** rostrum and antennule, dorsal. **B,** mandible. **C,** maxillule. **D,** maxilla. **E,** leg 1, anterior. **F,** leg 2 and intercoxal plate, anterior. **G,** endopod of leg 2, anterior. Scales in millimeters.

## RESULTS

### Taxonomy

Order Poecilostomatoida Thorell, 1859
Umazuracolidae n. fam.
*Umazuracola* n. gen.

*Female.* Body elongated and slightly laterally compressed. Rostrum linguiform. Cephalosome fused with first pediger; third and fourth pedigers coalescent; somites of urosome also fused. Paired genital apertures located dorsolaterally at two-thirds length of urosome. Caudal ramus with 6 setae plus rudimentary seta I. Antennule 7-segmented; formula of armature 5, 15, 5, 3, 4, 2 + aesthetasc, and 7 + aesthetasc. Antenna 3-segmented; endopod 2-segmented; second endopodal segment reflexed against proximal segment, furnished with pectinate, lamelliform plate. Mandible with 1 terminal and 1 subterminal blade. Maxillule represented by simple lobe tipped with 4 setae. Maxilla 2-segmented, consisting of unarmed, broad syncoxa and basis drawn out into serrate, spatulate process. Maxilliped indis-

tinctly 3-segmented; syncoxa robust and unarmed; basis narrow, with rudimentary distal seta; endopod tiny, drawn out into short spiniform process. Leg 1 biramous and reduced; protopod with outer distal seta; setal formula of exopod 1-0; 2,1,2; endopod 1-segmented and tipped with 3 setae. Legs 2 to 4 with 3-segmented exopod and 2-segmented endopod; both rami of legs 2 and 3 and endopod of leg 4 bearing stout, serrate spines. Leg 5 uniramous; protopod with outer seta; free exopodal segment with 2 outer and 2 terminal setae. Leg 6 represented by genital operculum armed with 1 spine and 2 setae. Egg-sac uniseriate.

*Male.* Body similar to but smaller than that of female. Paired genital opercula located ventrolaterally at midlength of urosome. Antennule, antenna, mandible, maxillule, and maxilla and legs 1–3 similar to those of female. Maxilliped well developed as grasping organ, 4-segmented. Legs 3 and 4 alike, with exopodal segments bearing stout, serrate spines; segmentation and setation of leg 5 as in female, but free exopodal segment much longer than protopodal segment; leg 6 represented by unarmed genital operculum.
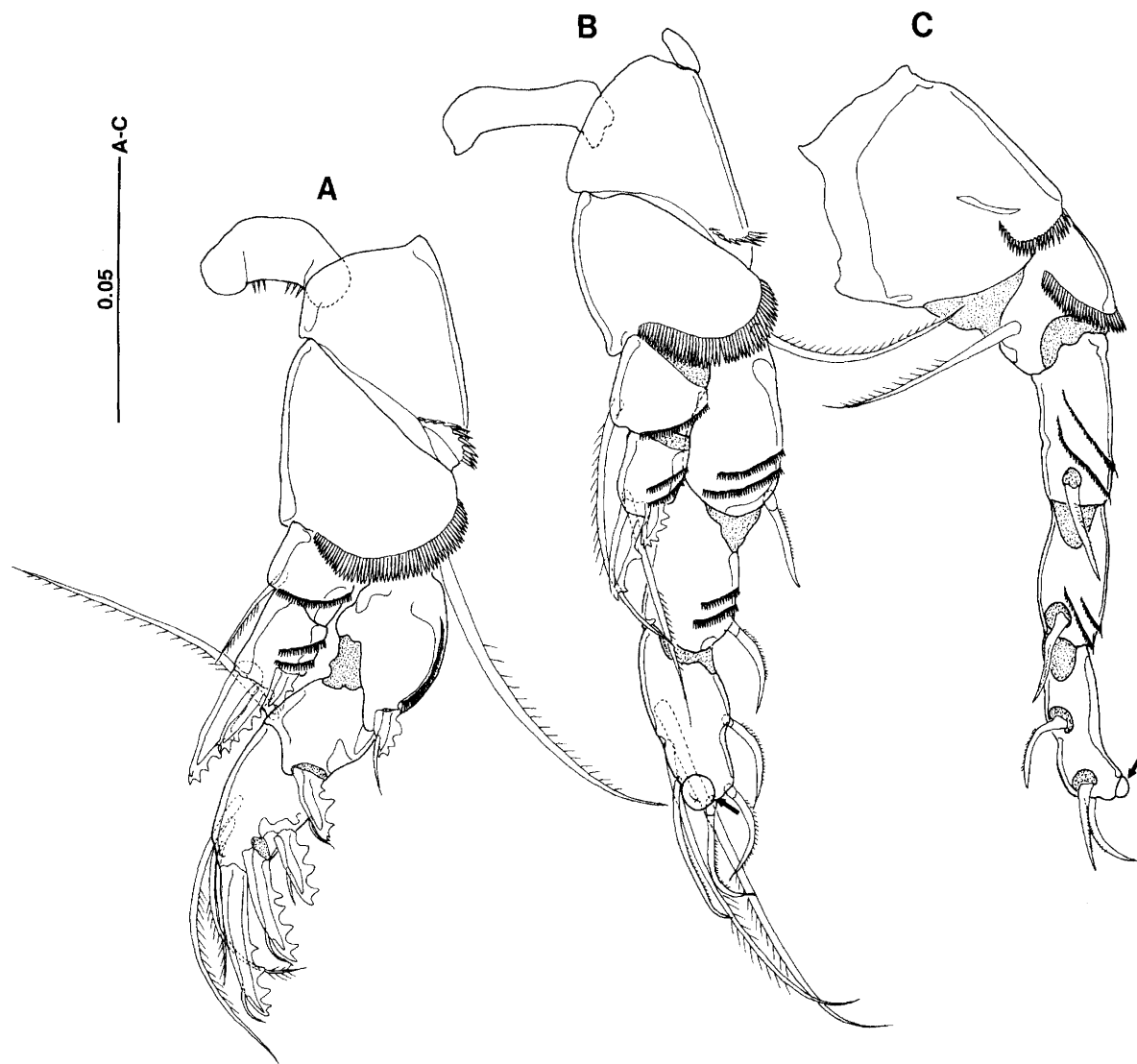


Fig. 3. *Umazuracola elongatus* n. g., n. sp., female (A, B, holotype; C, paratype). **A,** leg 3 and intercoxal plate, anterior. **B,** leg 4 and intercoxal plate, anterior, round knob on third exopodal segment arrowed. **C,** leg 4, lateral, round knob on third exopodal segment arrowed. Scale in millimeters.

*Type-species. Umazuracola elongatus* n. sp.

*Etymology.* The generic name is a combination of *Uma-zura* (the common name of the host in Japanese, meaning "horse face") and *cola* (Latin, meaning "dweller, inhabitant"). Gender masculine.
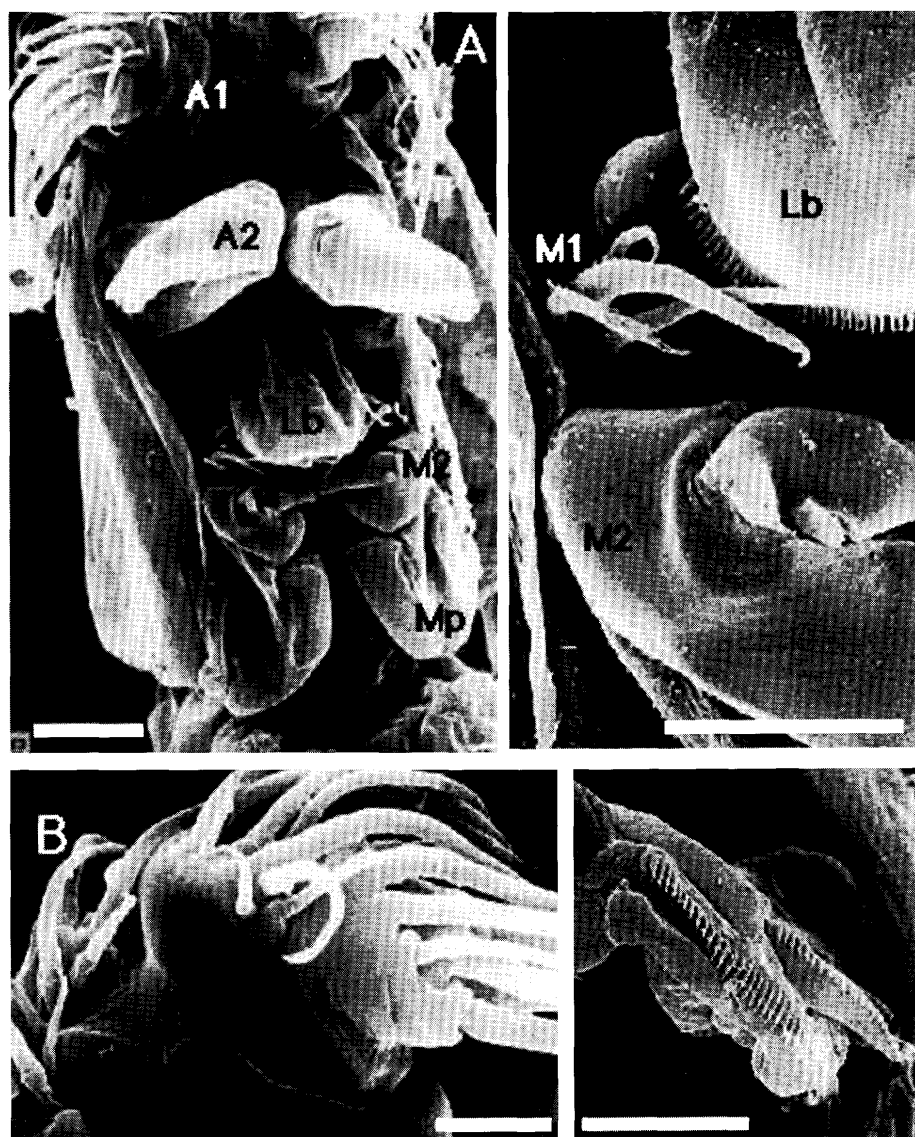
## *Umazuracola elongatus* n. sp.
(Figs. 1–6)

*Material examined.* Eighteen ♀♀ and 4 ♂♂ from body surface of 3 black scrapers, *Thamnaconus modestus* (Günther), caught in the Seto Inland Sea, western Japan, and purchased at a fish market at Imabari City in Ehime Prefecture on Shikoku Island: 5 ♀♀ and 2 ♂♂ from host 1 (236 mm in total length) purchased on 1 August 2003; 4 ♀ ♀ and 2 ♂♂ from host 2 (290 mm in total length) purchased on 9 May 2005; 9 ♀♀ from host 3 (300 mm in total length) purchased on 9 May 2005.

*Types.* Holotype (KMNH IvR 500, 126): 1 ♀, intact specimen, collected from host 1. Paratypes: 4 ♀♀ (2 intact, another 2 dissected and mounted on glass slides) and 2 ♂♂ (whole specimens) collected from host 1 (KMNH IvR 500, 127/132); 4 ♀♀ (whole specimens) and 12 ♂♂ (dissected and mounted on a glass slide) collected from host 2 (KMNH IvR 500, 133-138); and 9 ♀♀ (intact specimens) collected from host 3 (KMNH IvR 500, 139-147).

*Body length.* Female: 0.95–1.29 mm (mean±standard deviation 1.07±0.11 mm, N = 15), excluding setae on caudal rami; holotype length, 1.03 mm. Male: 0.78–0.85 mm (0.81± 0.03 mm, N = 4).

*Female.* Body (Fig. 1A, B) elongated and slightly laterally compressed. Rostrum (Figs. 1A, 2A) linguiform, clearly demarcated from cephalosome. Cephalothorax (Fig. 1A, B; see Fig. 4A) consisting of cephalosome and first pediger, about 1.8 times as long as wide. Third and fourth pedigers also fused together, with fusion line clearly visible. Somites of urosome fused into one and clearly demarcated from prosome, with dorsally protruded genital area and gradually tapered abdomen (Fig. 1B). Paired genital apertures (Fig. 1B, C; see Fig. 5C, D) located dorsolaterally at two-thirds length of urosome; numerous glandular pores present ante-



**Fig. 4.** SEM micrographs of *Umazuracola elongatus* n. g., n. sp., female. **A,** cephalothorax, ventral. **B,** proximal segments of left antennule, ventral. **C,** distal (endopodal) segment of antenna. **D,** labrum, maxillule and maxilla, ventral. Abbreviations: A1=antennule, A2=antenna, Lb=labrum, M1= maxillule, M2=maxilla, Mp=maxilliped. Scales: 0.02 mm in A; 0.01 mm in B–D.
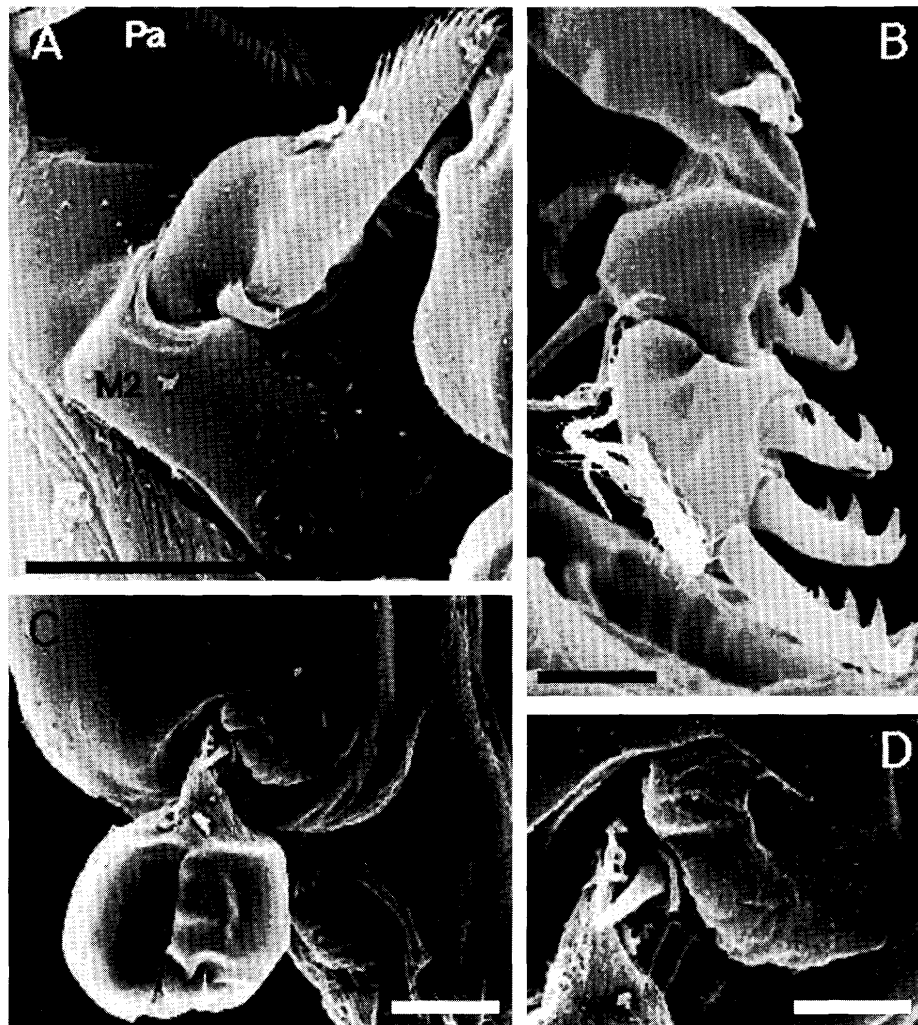
**Fig. 5.** SEM micrographs of *Umazuracola elongatus* n. g., n. sp., female. **A,** paragnath and maxilla. **B,** exopod of leg 3, anterior. **C,** genital area. **D,** leg 6. Abbreviations: M2=maxilla, Pa=paragnath. Scales: 0.01 mm in A, B, D; 0.02 mm in C.

rior to genital aperture. Caudal ramus (Fig. 1E) ca. 1.4 times as long as wide, armed with 6 short and 1 (seta V) long setae; seta I rudimentary; seta II and VII located dorsally. Egg sac (Fig. 1D) uniseriate, carrying up to 16 eggs.

Antennule (Fig. 2A) 7-segmented, proximal two segments short, broad, and heavily sclerotized (see Fig. 4A, B); setal formula 5, 15, 5, 3, 4, 2 + ae, and 7 + ae. Antenna (Fig. 1G, H) 3-segmented, consisting of coxobasis and 2-segmented endopod; proximal segment with rudimentary seta terminally; middle segment with medial seta in midlength. Terminal segment reflexed against middle segment (see Fig. 4A), with long pectinate lamella on ventral margin; armature on this segment including subterminally 1 pectinate process (see Fig. 4A) and 1 hooked spine, and terminally 3 hooked spines and 2 naked setae (Fig. 1H: see Fig. 4C). Labrum (Fig. 1F; see Fig. 4A, D) protruding ventrally, concave posterior margin fringed with row of spinules (Fig. 1F; see Fig. 4D). Mandible (Figs. 1F, 2B) with 1 subterminal and 1 terminal toothed blade. Paragnath (Fig. 1F) lobate, with terminal row of setules (see Fig. 5A). Maxillule (Figs. 1F, 2C) represented by small lobe tipped with 4 setae, one of which pinnate on one side (see Fig. 4D). Maxilla (Figs. 1F, 2D) 2-segmented; broad syncoxa unarmed; basis drawn out into serrate process with short spiniform seta on outer

margin (see Figs. 4A, D, 5A). Maxilliped (Fig. 1F; see Fig. 4A) highly reduced and indistinctly 3-segmented; syncoxa broad, unarmed; basis bearing rudimentary terminal seta; endopod drawn out into slender spiniform process tapering distally. Legs 1–4 biramous, with 3-segmented exopod and 2-segmented endopod, except leg 1. Armature of these legs as follows (Roman numerals indicating spines and Arabic numerals, setae):

|        | Coxa | Basis | Exopod          | Endopod   |
|--------|------|-------|-----------------|-----------|
| Leg 1  | 0–0  | 1–0   | 1–0; 2,1,2      | 1,1,1     |
| Leg 2  | 0–0  | 1–0   | I–0; I–1; II,I,3 | 0–1; I,II,2 |
| Leg 3  | 0–0  | 1–0   | I–0; I–1; II,I,3 | 0–1; I,II,0 |
| Leg 4  | 0–0  | 1–0   | 1–0; 1–0; 2,1,3 | 0–1; I,I,1 |

Leg 1 (Fig. 2E) highly reduced, coxa and basis completely fused and bearing long outer, basal seta; intercoxal plate broad, furnished with row of setules along outer distal and central margins. Leg 2 (Fig. 2F) with row of spinules on outer distal corner of coxa; basis shorter than coxa, bearing long outer seta and transverse row of spinules along distal margin; intercoxal plate narrow. First exopodal segment with row of tightly arranged spinules along outer margin; all outer spines strongly serrate and carrying minute medial setule
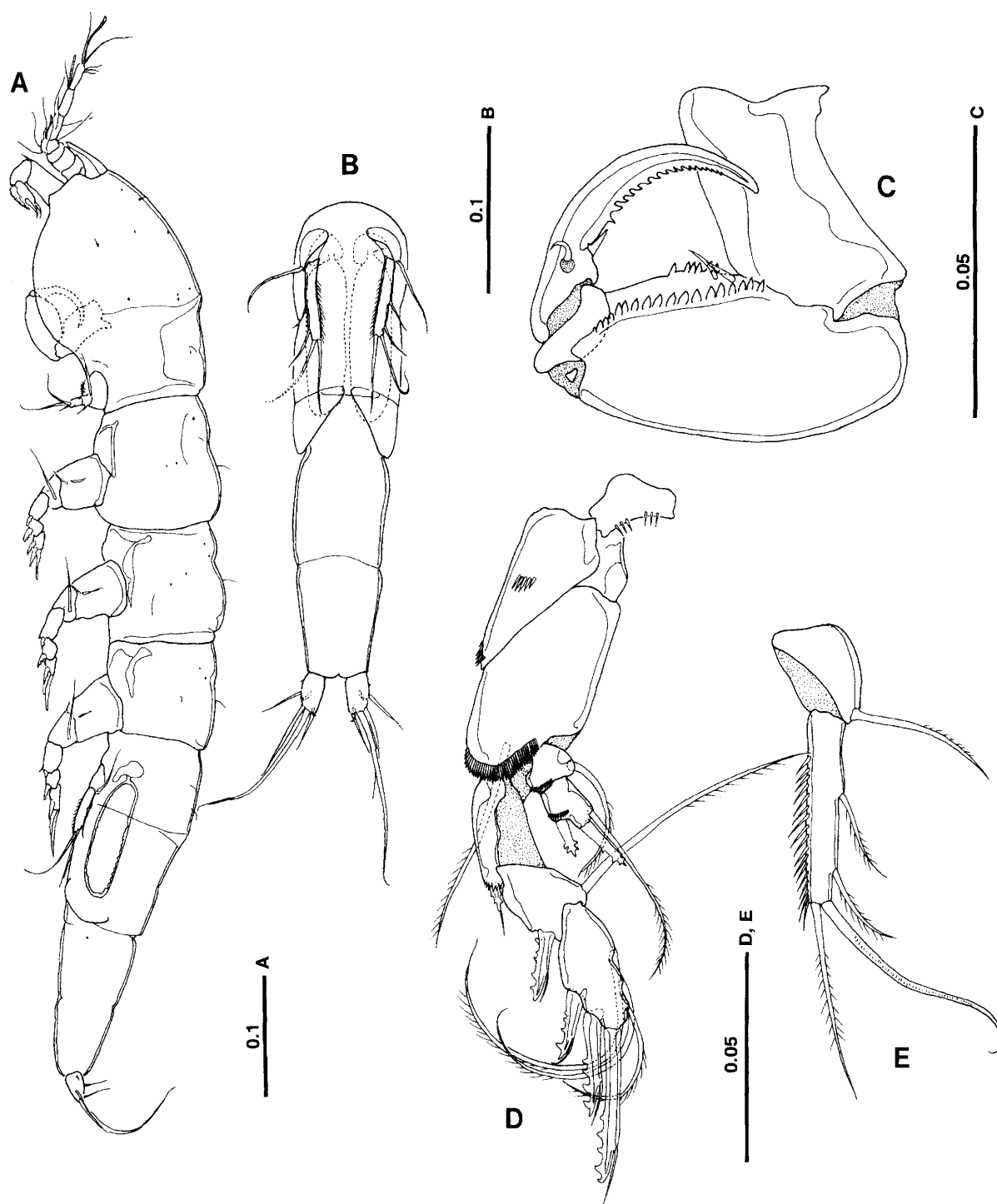
**Fig. 6.** *Umazuracola elongatus* n. g., n. sp., male (paratype). **A,** habitus, lateral. **B,** urosome, ventral. **C,** maxilliped. **D,** leg 4, anterior. **E,** leg 5, anterior. Scales in millimeters.

(see Fig. 5B). Endopod about half as long as exopod; first segment with 1 and second segment with 2 oblique rows of tightly arranged spinules on anterior surface (Fig. 2G). Left endopod of leg 2 on holotype aberrant, its second segment shorter than that in normal right leg and bearing single terminal spine. Leg 3 (Fig. 3A) resembling leg 2 in segmentation, ornamentation, and armature, but no seta on second endopodal segment; intercoxal plate wider than long. Protopod of leg 4 (Fig. 3B) as in legs 2 and 3, but exopod prolonged; each of first two segments with two rows of minute spinules and one spiniform seta, third segment bearing

round terminal knob (arrowed in Fig. 3B, C), and 1 terminal and 2 outer spiniform setae and 3 inner pinnate setae; endopod one-third as long as exopod; proximal segment with 1 and distal segment with 2 oblique rows of tightly arranged spinules. Leg 5 (Fig. 1B, I) rudimentary and uniramous; protopod with outer seta; exopod 1-segmented and carrying 2 outer and 2 terminal setae. Leg 6 (Fig. 1C; see Fig. 5C, D) represented by 1 spine and 2 setae located on genital operculum.

*Male.* Body (Fig. 6A) similar to but smaller than that of female. Urosome (Fig. 6B) incompletely 3-segmented; fifth

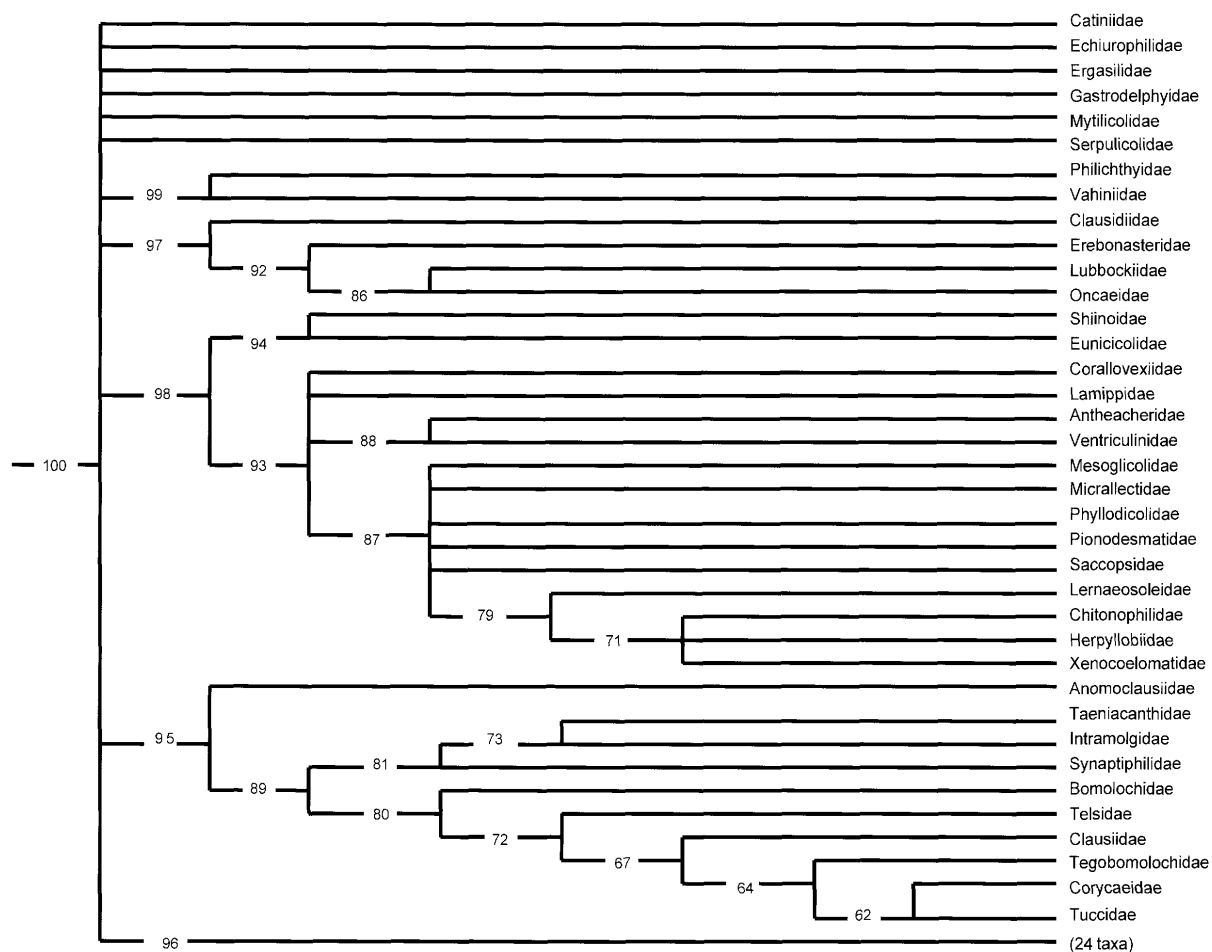J.-S. Ho *et al.*

**Fig. 7.** Cladogram of Poecilostomatoida produced through analysis of 138 morphological characters. Clade 96 is shown in Fig. 8.
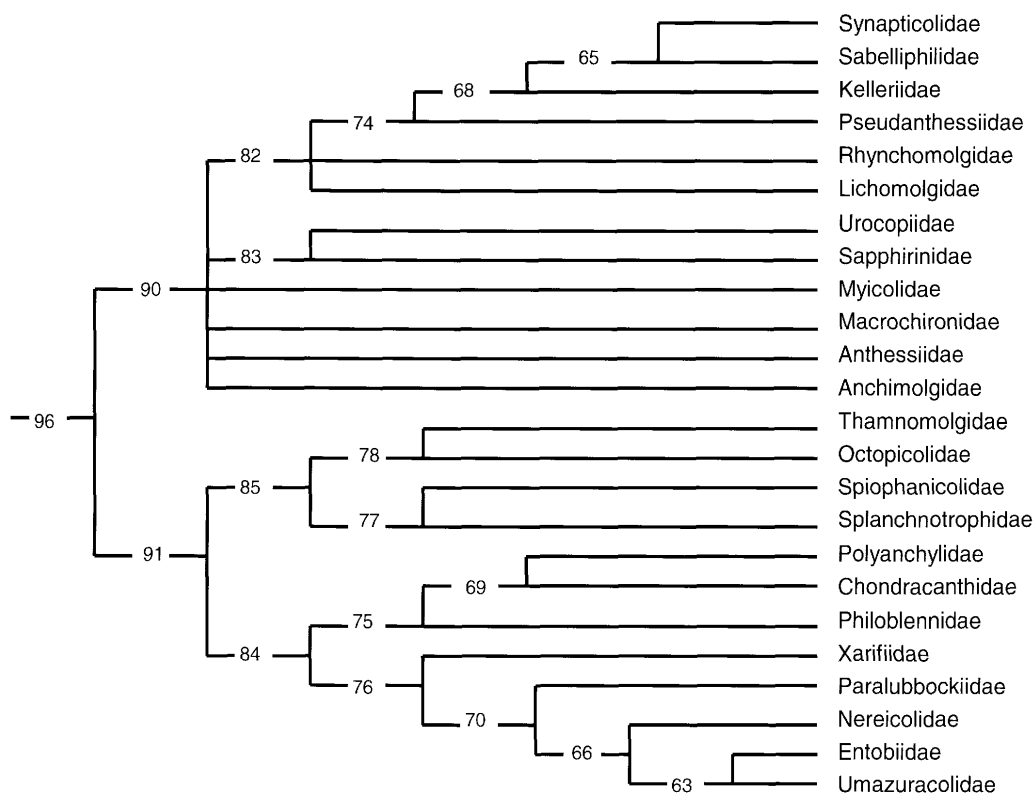
**Fig. 8.** Partial cladogram of Poecilostomatoida showing clade 96 (see Fig. 7 for position of clade).

pediger fused to genital somite, with suture clearly visible dorsally and laterally; genital somite with paired genital flaps; paired spermatophores in anterior part of urosome; abdomen 1-segmentred, tapering distally, with constriction midway. Caudal rami as in female.

Antennule, antenna, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 6C) highly developed, 4-segmented; first segment (syncoxa) robust, unarmed; second segment (basis) expanded midway, with two rows of blunt teeth along medial margin and 2 short, basal setae; third segment (first endoposal segment) small, unarmed; fourth segment (second endopodal segment) drawn out into smoothly curved claw with 2 short, basal setae and serration along medial margin.

Legs 1 to 3 similar to those of female. Leg 4 (Fig. 6D) with spines (instead of setae) on exopod bearing teeth only on outer margin; no round knob on third exopodal segment; intercoxal sclerite with rows of spinules along posterior margin. Leg 5 (Fig. 6B, E) 2-segmented, free exopodal segment much longer than protopodal segment and with row of spinules along inner margin. Leg 6 (Fig. 6B) represented by unarmed genital flap.

*Etymology.* The specific name "*elongatus*" is from Latin, meaning "elongate," alluding to the elongated body in this new species.

## Phylogenetic analysis

A cladistic analysis was undertaken to elucidate the phylogenetic relationships of the new family with the other 60 families in the Poecilostomatoida. The analysis produced 100 trees with a length of 560 steps, consistency index (CI) of 0.24, and retention index (RI) of 0.74. Since the purpose of this analysis was to investigate phylogenetic relationships among families, the special command "Nelsen" in HENNIG86 was used to construct a strict consensus tree for the 100 trees obtained. This strict consensus tree is reproduced in Fig. 7, with the topography of one of its branches, clade 96, given separately in Fig. 8. The synapomorphies on the 39 nodes (62 to 100) of this tree are listed in Appendix 3.

## DISCUSSION

Having an antenna armed with a claw on the second endopodal segment, a mandible with 2 distal blades, a maxillule tipped with 4 elements, and a maxilla with a spinulose terminal process, *Umazuracola elongatus* resembles a group of poecilostmaoid families called the "bomolochiform complex" (Dojiri and Cressey, 1987; Ho, 1991; Boxshall and Halsey, 2004). The complex, comprising the families Bomolochidae, Taeniacanthidae, Tegobomolochidae, Telsidae, and Tuccidae, was characterized by Dojiri and Cressey (1987) as sharing the following five characters: (1) indistinctly 4-segmented antenna with two pectinate processes, claw-like spines, and setae; (2) mandible with two subequal spinulated blades; (3) maxilla bearing spinulose elements; (4) an indented (concave) ventral surface of the cephalothorax; and (5) lamelliform leg 1. The family Telsidae differs from the other four families in the complex in having a cephalothorax without concave ventral surface and an unmodified (not lamelliform) leg 1 (Ho, 1967); *U. elongatus* also shows these differences. However, the maxilliped and the four pairs of legs on *U. elongatus* are so different from those

of the Telsidae that it cannot be placed in the latter family. Thus, we proposed a new family to accommodate *U. elongatus*.

Sixty-one families of copepods are currently known in the order Poecilostomatoida. The family Pharodidae Illg, 1948, one of the 61 families listed in Poecilostomatoida by Martin and Davis (2001), was recently synonymized with Chondracanthidae Milne Edwards, 1840 by Østergaard *et al.* (2003). Additionally, another family, Nucellicolidae Lamb, Boxshall, Mill, and Grahame, 1996, was relegated as a synonym of Chitonophilidae Avdeev and Sirenko, 1991 by Boxshall and Halsey (2004). However, with the resurrection of a forgotten poecilostomatoid family, Pionodesmotidae Bonnier, 1898 – containing endoparasites of sea urchins – by Boxshall and Halsey (2004) and our addition of a new family, the number of poecilostomatoid families remains 61, as stated in MATERIALS AND METHODS.

It is interesting that in Ho's (1991) original analysis of the Poecilostomatoida, the families Corycaeidae and Clausiidae appeared in monophyly with the five families of the bomolochiform complex. These families again appeared in the same clade (clade 89) in our analysis (see Fig. 7), and share as synapomorphies characters 17 (antenna with claw on penultimate segment) and 22 (mandible a process with 3 terminal elements). Also, eight (Anchimolgidae, Kelleriidae, Lichomolgidae, Macrochironidae, Pseudanthessiidae, Rhynchomolgidae, Sabelliphilidae, and Synapticolidae) of the ten (plus Octopicolidae and Thamnomolgidae) families of the "lichomolgoid complex" recognized by Humes and Boxshall (1996) comprise a monophyletic group (clade 90; see Fig. 8) containing also four other families (Anthessiidae, Myicolidae, Sapphirinidae, and Urocopiidae). The synapomorphies for this clade are characters 25 (mandible lashlike), 31 (maxillule unilobate with 4 elements), and 110 (terminal segment of leg 4 exopod with 9 elements).

Much to our surprise, our parsimony analysis showed the new family Umazuracolidae not to be a member of the bomolochiform complex, despite its resemblance to the latter in the structure of the antenna, mandible, maxillule, and maxilla. Examination of the list of the synapomorphies for node 95 (Appendix 3) indicated that Umazuracolidae is excluded from the bomolochiform complex (clade 95 in Fig. 8) chiefly by lacking character 43 (maxilliped endopod a claw), reversal of character 66 (leg 1 basis without medial seta), and absence of character 125 (middle endopodal segment of leg 4 with 1 medial seta). Umazuracolidae is the sister-taxon to a polychaete-parasitizing family, Entobiidae Ho, 1984, sharing characters 28 (bilobate maxillule), 64 (1-segmented leg 1 endopod), and 133 (leg 5 reduced to a seta). It is interesting that the sister-taxon of Umazuracolidae + Entobiidae is another polychaete-parasitizing family, Nereicolidae Claus, 1875. This suggests that the fish-parasitizing *Umazuracola* has evolved from a copepod parasitic on polychaetes.

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**Appendix 1.** Apomorphic states of characters of the poecilostomatoid families used in the cladistic analysis.

| CHARACTER | CHARACTER STATES | CHARACTER | CHARACTER STATES |
|---|---|---|---|
| 1 | First pediger separated from cephalosome | 70 | Leg 2 exopod $3^{rd}$ segment with 7 elements |
| 2 | Urosome (including caudal ramus) short, less than 1/3 of prosome | 71 | Leg 2 exopod $3^{rd}$ segment with 6 elements |
|  |  | 72 | Leg 2 exopod $3^{rd}$ segment with 4 elements |
| 3 | Abdomen 4-segmented | 73 | Leg 2 exopod $3^{rd}$ segment with 3 elements |
| 4 | Abdomen 2-segmented | 74 | Leg 2 exopod $3^{rd}$ segment without armature |
| 5 | Abdomen 1-segmented | 75 | Leg 2 exopod 2-segmented |
| 6 | Antennule 8-segmented | 76 | Leg 2 exopod 1-segmented |
| 7 | Antennule 7-segmented | 77 | Leg 2 endopod $3^{rd}$ segment with 7 elements |
| 8 | Antennule 6-segmented | 78 | Leg 2 endopod $3^{rd}$ segment with 5 elements |
| 9 | Antennule 5-segmented | 79 | Leg 2 endopod $3^{rd}$ segment with 4 elements |
| 10 | Antennule 4-segmented | 80 | Leg 2 endopod $3^{rd}$ segment with 3 elements |
| 11 | Antennule 2-segmented | 81 | Leg 2 endopod $3^{rd}$ segment with 2 elements |
| 12 | Antennule 1-segmented | 82 | Leg 2 endopod $3^{rd}$ segment with 1 element |
| 13 | Antennule absent | 83 | Leg 2 endopod $3^{rd}$ segment without armature |
| 14 | Antenna 3-segmented | 84 | Leg 2 endopod 2-segmented |
| 15 | Antenna 2-segmented | 85 | Leg 2 endopod 1-segmented |
| 16 | Antenna with claw(s) on terminal segment | 86 | Leg 2 endopod absent |
| 17 | Antenna with claw (s) on penultimate segment | 87 | Leg 2 endopod $2^{nd}$ segment with 1 medial seta |
| 18 | Antenna modified into a uncinate appendage | 88 | Leg 2 endopod $2^{nd}$ segment without medial seta |
| 19 | Antenna bomolochiform, with endopod folded back over coxobasis | 89 | Leg 2 modified into a lobe |
|  |  | 90 | Leg 2 absent |
| 20 | Antenna absent | 91 | Leg 3 exopod $3^{rd}$ segment with 8 elements |
| 21 | Mandible a process with 4 terminal elements | 92 | Leg 3 exopod $3^{rd}$ segment with 7 elements |
| 22 | Mandible a process with 3 terminal elements | 93 | Leg 3 exopod $3^{rd}$ segment with 6 elements |
| 23 | Mandible a process with 2 terminal elements | 94 | Leg 3 exopod $3^{rd}$ segment with 4 elements |
| 24 | Mandible a small blade | 95 | Leg 3 exopod $3^{rd}$ segment with 3 elements |
| 25 | Mandible lash-like | 96 | Leg 3 exopod $3^{rd}$ segment without armature |
| 26 | Mandible a tapering blade | 97 | Leg 3 exopod 2-segmented |
| 27 | Mandible absent | 98 | Leg 3 exopod 1-segmented |
| 28 | Maxillule bilobate | 99 | Leg 3 endopod $3^{rd}$ segment with 5 elements |
| 29 | Maxillule unilobate with 6 elements | 100 | Leg 3 endopod $3^{rd}$ segment with 4 elements |
| 30 | Maxillule unilobate with 5 elements | 101 | Leg 3 endopod $3^{rd}$ segment with 3 elements |
| 31 | Maxillule unilobate with 4 elements | 102 | Leg 3 endopod $3^{rd}$ segment with 2 elements |
| 32 | Maxillule unilobate with 3 elements | 103 | Leg 3 endopod $3^{rd}$ segment with 1 element |
| 33 | Maxillule unilobate with 2 elements | 104 | Leg 3 endopod 2-segmented |
| 34 | Maxillule absent | 105 | Leg 3 endopod 1-segmented |
| 35 | Maxilla basis with 4 elements | 106 | Leg 3 endopod absent |
| 36 | Maxilla basis with 3 elements | 107 | Leg 3 endopod $2^{nd}$ segment with 1 medial seta |
| 37 | Maxilla basis with 2 elements | 108 | Leg 3 modified into a sac without seta |
| 38 | Maxilla basis with 1 element | 109 | Leg 3 absent |
| 39 | Maxilla basis unarmed | 110 | Leg 4 exopod $3^{rd}$ segment with 9 elements |
| 40 | Maxilla absent | 111 | Leg 4 exopod $3^{rd}$ segment with 7 elements |
| 41 | Maxilliped with 2-segmented endopod | 112 | Leg 4 exopod $3^{rd}$ segment with 6 elements |
| 42 | Maxilliped endopod a pointed process | 113 | Leg 4 exopod $3^{rd}$ segment with 5 elements |
| 43 | Maxilliped endopod a claw | 114 | Leg 4 exopod $3^{rd}$ segment with 3 elements |
| 44 | Maxilliped endopod a spinulose lobe | 115 | Leg 4 exopod $3^{rd}$ segment without armature |
| 45 | Maxilliped (2-segmented) endopod absent | 116 | Leg 4 exopod 2-segmented |
| 46 | Maxilliped absent | 117 | Leg 4 exopod 1-segmented |
| 47 | Leg 1 exopod $3^{rd}$ segment with 9 elements | 118 | Leg 4 endopod $3^{rd}$ segment with 4 elements |
| 48 | Leg 1 exopod $3^{rd}$ segment with 7 elements | 119 | Leg 4 endopod $3^{rd}$ segment with 3 elements |
| 49 | Leg 1 exopod $3^{rd}$ segment with 6 elements | 120 | Leg 4 endopod $3^{rd}$ segment with 2 elements |
| 50 | Leg 1 exopod $3^{rd}$ segment with 5 elements | 121 | Leg 4 endopod $3^{rd}$ segment with 1 element |
| 51 | Leg 1 exopod $3^{rd}$ segment with 4 elements | 122 | Leg 4 endopod 2-segmented |
| 52 | Leg 1 exopod $3^{rd}$ segment with 3 elements | 123 | Leg 4 endopod 1-segmented |
| 53 | Leg 1 exopod $3^{rd}$ segment without armature | 124 | Leg 4 endopod absent |
| 54 | Leg 1 exopod 2-segmented | 125 | Leg 4 endopod $2^{nd}$ segment with 1 medial seta |
| 55 | Leg 1 exopod 1-segmented | 126 | Leg 4 modified into a sac without seta |
| 56 | Leg 1 endopod $3^{rd}$ segment with 7 elements | 127 | Leg 4 absent |
| 57 | Leg 1 endopod $3^{rd}$ segment with 5 elements | 128 | Leg 5 2-segmented, terminal segment with 4 elements |
| 58 | Leg 1 endopod $3^{rd}$ segment with 4 elements | 129 | Leg 5 2-segmented, terminal segment with 2 elements |
| 59 | Leg 1 endopod $3^{rd}$ segment with 3 elements | 130 | Leg 5 1-segmented and armed with 4 elements |
| 60 | Leg 1 endopod $3^{rd}$ segment with 2 elements | 131 | Leg 5 1-segmented and armed with 3 elements |
| 61 | Leg 1 endopod $3^{rd}$ segment with 1 elements | 132 | Leg 5 1-segmented and armed with 2 elements |
| 62 | Leg 1 endopod $3^{rd}$ segment without armature | 131 | Leg 5 1-segmented and armed with 3 elements |
| 63 | Leg 1 endopod 2-segmented | 132 | Leg 5 1-segmented and armed with 2 elements |
| 64 | Leg 1 endopod 1-segmented | 133 | Leg 5 reduced to a seta |
| 65 | Leg 1 endopod absent | 134 | Leg 5 absent |
| 66 | Leg 1 basis without medial seta | 135 | Leg 6 represented by 4 setae on genital operculum |
| 67 | Leg 1 modified into a lobe | 136 | Leg 6 represented by 2 setae on genital operculum |
| 68 | Leg 1 absent | 137 | Leg 6 represented by 1 seta on genital operculum |
| 69 | Leg 2 exopod $3^{rd}$ segment with 8 elements | 138 | Leg 6 absent |

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**Appendix 2.** Character matrix

| Taxon (family) | Characters | | | | | |
|---|---|---|---|---|---|---|
| ANCHIM | 0000001000 | 0000010000 | 0000100000 | 1000001000 | 0100000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000010 | 0000000001 | 0000000001 |
| | 0100?00000 | 01000100 | | | | |
| ANOMOC | 0100001000 | 0000010000 | 0100000100 | 0000000100 | 0010000000 | 0100000000 |
| | 1010000000 | 0010000000 | 010100?000 | 0000100000 | 001100?000 | 0001000000 |
| | 1100?00100 | 00000010 | | | | |
| ANTHEA | 1001000000 | 0011000000 | 000000?000 | 000?000010 | 0000100000 | 0011000000 |
| | 0110010000 | 0001100000 | 001100?000 | 0000000000 | 0000011010 | 0000000000 |
| | 0000001000 | 000?0001 | | | | |
| ANTHES | 1000001000 | 0000010000 | 0010000000 | 1000001000 | 1000000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 0000000001 | 0000000000 |
| | 0000000001 | 00000100 | | | | |
| BOMOLO | 0000010000 | 0000011010 | 0100000001 | 0000001000 | 0010000000 | 0000000000 |
| | 0000000000 | 0000000100 | 0000000000 | 0000000001 | 0000000001 | 0000000010 |
| | 0000100100 | 00000000 | | | | |
| CATINI | 0000000100 | 0000000000 | 1000000001 | 0000100000 | 0000010100 | 0000000000 |
| | 0000000001 | 0000000000 | 0000001000 | 1000000000 | 0000001000 | 0000000100 |
| | 0000100100 | 00000000 | | | | |
| CHITON | 0000?00000 | 0010000001 | 0000001000 | 0001000001 | 0000010000 | 0000000000 |
| | 0000110100 | 0000000000 | 0000011001 | 0000000000 | 0000011010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| CHONDR | 1101000100 | 0000101100 | 0000010000 | 0100000001 | 0000010000 | 0000000000 |
| | 0000110110 | 0000100000 | 000100?000 | 0010001000 | 010100?000 | 0000000000 |
| | 0001001000 | 10000100 | | | | |
| CLAUSD | 0010001000 | 0000000000 | 0000000100 | 0000010000 | 1000000000 | 0000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000001 | 0000000000 |
| | 0000000100 | 00000000 | | | | |
| CLAUSI | 0010000100 | 0000011000 | 0010000000 | 1000001000 | 1000000100 | 0000001000 |
| | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000001 | 0000000100 |
| | 0000000100 | 00000100 | | | | |
| CORALL | 1000?00000 | 1001010000 | 0000001000 | 000?00000? | 00000?0000 | 0000000000 |
| | 0000001000 | 0000000000 | 0000000010 | 0000000000 | 0000011010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| CORYCA | 0000100100 | 0000011000 | 1000000100 | 0000010000 | 0010000000 | 0000001000 |
| | 0000010000 | 0000000010 | 0000000000 | 0000000000 | 0100000000 | 1000000001 |
| | 0010000000 | 00100010 | | | | |
| ECHIUR | 0000000100 | 0000011000 | 0001000000 | 0100000100 | 0000010010 | 0000001000 |
| | 0000000000 | 1000000100 | 0000001000 | 0010000001 | 0000001000 | 0100000010 |
| | 0000500100 | 00000001 | | | | |
| ENTOBI | 1000500000 | 1001000000 | 0010000000 | 1000000001 | 0010000000 | 00???00000 |
| | 0???010000 | 000???0000 | 00???0?000 | 0000???00 | 000??0?000 | 0000???000 |
| | 0??0?00000 | 00100001 | | | | |
| EREBON | 1000001000 | 0000000000 | 1000000100 | 0000001000 | 1000000000 | 0000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 |
| | 0000000100 | 00000100 | | | | |
| ERGASI | 0100000100 | 0000010000 | 0100000000 | 0100000100 | 0000010100 | 0000000000 |
| | 0000010001 | 0000000100 | 0000000000 | 0100000010 | 0000000000 | 0010010100 |
| | 0000000010 | 00000001 | | | | |
| EUNICI | 0000001000 | 0001010000 | 1000000000 | 0100001000 | 0100000001 | 0000000001 |
| | 0010010000 | 1000000001 | 000100?000 | 0000101000 | 0000010000 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| GASTRO | 1100000010 | 0000010000 | 0010000000 | 0100000010 | 0000010100 | 0000001000 |
| | 0000010010 | 0000000100 | 0000000000 | 0010000000 | 1000000000 | 0000000000 |
| | 0000010000 | 00010100 | | | | |
| HERPYL | 0100?00000 | 0010000001 | 0000001000 | 0001000001 | 0000010000 | 0000000000 |
| | 0000110100 | 0000000000 | 000001?001 | 0000000000 | 000001?010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| INTRAM | 0100001000 | 0000011000 | 0000000010 | 0000010000 | 0010000100 | 0000000000 |
| | 0000010010 | 0000000000 | 0000000000 | 1000000000 | 0000000000 | 0000000100 |
| | 0000000000 | 00100000 | | | | |
| KELLER | 1000001000 | 0000011000 | 0000100000 | 1000010000 | 0000000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000010 | 0000000000 | 0000000010 |
| | 0010?00000 | 01000100 | | | | |
| LAMMIP | 0001000010 | 0000010000 | 0000001000 | 0001000001 | 0010000000 | 0101000001 |
| | 0001010000 | 0010100000 | 100010?000 | 0000000000 | 0000010010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| LERNAE | 0100?00000 | 0100000100 | 0000001000 | 0001000001 | 0000010000 | 0000000000 |
| | 0000?11000 | 0000000000 | 0000011001 | 0000000000 | 0000011010 | 0000000000 |
| | 0001101000 | 00010001 | | | | |
| LICHOM | 0000001000 | 0000010000 | 0000100000 | 1000010000 | 0100000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 0000000001 | 0000000010 |
| | 0000100000 | 01000100 | | | | |
| LUBBOC | 1000001000 | 0000010000 | 1000000100 | 0000100000 | 10100000000 | 000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 1000000000 | 0000000000 | 0000000000 |
| | 0000000000 | 01000100 | | | | |
| MACROC | 1000001000 | 0000001000 | 0000100000 | 1000001000 | 0010000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000010 | 0000000001 | 0000000001 |
| | 0010?00000 | 01000100 | | | | |
| MESOGL | 1010000000 | 1001011000 | 0000001000 | 0001000010 | 00000?0000 | 0000000000 |
| | 0000110100 | 0000000000 | 0000010001 | 0000000000 | 0000010010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| MICRAL | 0100?00000 | 1001000000 | 0100000000 | 1000000?0 | 0001000000 | 0000000000 |
| | 0000110100 | 0000000000 | 0000010001 | 0000000000 | 0000010010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| MYICOL | 0000001000 | 0001010000 | 1000000000 | 1000001000 | 00000?0000 | 0000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000001 | 0000000000 |
| | 0000000100 | 00000100 | | | | |
| MYTILI | 1101000000 | 0001010000 | 0000001000 | 0010000010 | 0000010000 | 0000000100 |
| | 0000010010 | 0000000000 | 0000000000 | 1000000001 | 0000000000 | 1000000010 |
| | 0000000001 | 00000100 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| NEREIC | 1100101000 | 0001010000 | 0010000100 | 0000000010 | 0001000000 | 00?1000000 |
| | 0?10010000 | 000?100000 | 00?1000000 | 00000?1000 | 00010000000 | 0000000000 |
| | 000?010000 | 00100100 | | | | |
| OCTOPI | 1010001000 | 0000011000 | 0000010000 | 0010001000 | 0100000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000010 | 0000000000 | 0000000010 |
| | 0010000000 | 01000100 | | | | |
| ONCAEI | 1000001000 | 0001000000 | 0000000100 | 0000000000 | 1000000000 | 0000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 0000000010 | 0000000000 | 0000000000 |
| | 0000000000 | 01000100 | | | | |
| PARALU | 1000001000 | 0000100000 | 0100000100 | 0000010000 | 1000000010 | 0000000000 |
| | 0010010001 | 0000001000 | 000100?000 | 0100000000 | 000100?000 | 1000000100 |
| | 0100?00000 | 01000100 | | | | |
| PHILIC | 1010010000 | 0000000001 | 0000001000 | 1000100000 | 0000?00000 | 0101000000 |
| | 0101010000 | 0100100000 | 001010?000 | 0000000000 | 00000??100 | 0000000000 |
| | 000??10000 | 0000100 | | | | |
| PHILOB | 0000000100 | 0001010000 | 0000010000 | 1000010000 | 0100000010 | 0000000000 |
| | 0010010000 | 1000000100 | 000100?000 | 0000000000 | 00000?0100 | 0000000000 |
| | 0001001000 | 01000100 | | | | |
| PHYLLO | 0000?00000 | 0100010000 | 0000001000 | 0001000001 | 0010000000 | 0000000000 |
| | 0000110100 | 0000000000 | 0000010001 | 0000000000 | 0000010010 | 0000000000 |
| | 0001001000 | 00010100 | | | | |
| PIONOD | 1100100100 | 0000001000 | 000000?100 | 0000?00000 | 0010000000 | 0000000000 |
| | 0000110100 | 0000000000 | 0000010001 | 0000000000 | 0000010010 | 0000000000 |
| | 0001001000 | 0001000? | | | | |
| POLYAN | 1000000100 | 0000110000 | 0000010000 | 1000001000 | 0010000100 | 0000010000 |
| | 0010010010 | 0000001000 | 000100?000 | 1000000000 | 000100?000 | 0010001000 |
| | 0001000000 | 01000010 | | | | |
| PSEUDA | 1000001000 | 0000010000 | 0000100000 | 1000010000 | 0100000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 |
| | 0100?00000 | 00100100 | | | | |
| RHYNCH | 1000001000 | 0000010000 | 0000100000 | 1000010000 | 0100000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 0000000001 | 0000000000 |
| | 0000000000 | 01000100 | | | | |
| SABELL | 1000001000 | 0000011000 | 0000010000 | 1000010000 | 0010000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 |
| | 0000100000 | 01000100 | | | | |
| SACOOP | 1100?00100 | 0000100000 | 0000001000 | 000100?000 | 0000010000 | 0000000000 |
| | 0000110100 | 0000000000 | 0000010001 | 0000000000 | 0000010010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| SAPPHI | 0000000100 | 0000010000 | 0000010000 | 1000001000 | 0010000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000010 | 0000000000 | 0000000000 |
| | 0000100000 | 01000100 | | | | |
| SERPUL | 1000?00100 | 0000000000 | 0000010000 | 0100001000 | 0001000010 | 0000000100 |
| | 0000000010 | 0000000001 | 0000001000 | 1000000000 | 1000001000 | 0000000010 |
| | 0000100001 | 00001000 | | | | |
| SHIINO | 0000001000 | 0000101000 | 0010000000 | 0100001000 | 0000010010 | 0000000010 |
| | 0000010000 | 1000000001 | 0000000100 | 0000000000 | 0000000100 | 0000000000 |
| | 0001001000 | 00010100 | | | | |
| SPIOPH | 1000100100 | 0000000000 | 0000010000 | 0010001000 | 1010000000 | 0010100100 |
| | 0001010000 | 0001010001 | 000010?000 | 0000010100 | 100010?000 | 0000101001 |
| | 0010?00000 | 01000001 | | | | |
| SPLANC | 1001000001 | 0001010000 | 0000010000 | 0010001000 | 0000010000 | 0010100000 |
| | 0101010000 | 0001010000 | 001010?000 | 0000000000 | 0000000100 | 0000000000 |
| | 0001001000 | 01000100 | | | | |
| SYNAPC | 1000001000 | 0000001000 | 0000010000 | 1000010000 | 0100000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 |
| | 0000000000 | 01000100 | | | | |
| SYNAPP | 0000000100 | 0000001000 | 0100000000 | 1000010000 | 0000100000 | 0000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000100 |
| | 0100?00100 | 0000000? | | | | |
| TAENIA | 0010001000 | 0000011010 | 0100000010 | 0000010000 | 0010000000 | 0000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 1000000000 | 0000000000 | 0000000100 |
| | 0000100100 | 00000000 | | | | |
| TEGOBO | 0000000100 | 0000011010 | 0010000000 | 1000010000 | 0010001000 | 0001001000 |
| | 0000010001 | 0000000100 | 0000000000 | 0100000000 | 1000000000 | 1000000010 |
| | 0000000100 | 00000001 | | | | |
| TELSID | 0000000100 | 0000011010 | 0010000000 | 1000000010 | 0010000000 | 0000000000 |
| | 0000000000 | 0000000000 | 0000000000 | 1000000001 | 0000000000 | 0010000010 |
| | 0000100100 | 00000000 | | | | |
| THAMNO | 1000001000 | 0000010000 | 0000010000 | 0010001000 | 0000000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 001010?000 | 0000010000 |
| | 1010?00000 | 01000100 | | | | |
| TUCCID | 0100?00010 | 0000011010 | 0010000000 | 1000010000 | 0010000100 | 0000001000 |
| | 0000000000 | 0000001000 | 000100?000 | 0000000000 | 001010?000 | 0000010000 |
| | 1010?00000 | 10000001 | | | | |
| UMAZUR | 0000?01000 | 0001011010 | 0010000000 | 1000000100 | 0100000001 | 0001000010 |
| | 0001010000 | 1000000000 | 000100?000 | 0010000000 | 100100?000 | 0100000010 |
| | 0100?00001 | 00000000 | | | | |
| UROCOP | 1000000100 | 0000010000 | 0000100000 | 1000001000 | 0010000000 | 0000000000 |
| | 0000010000 | 0000000000 | 0000000000 | 0000000000 | 0000000000 | 0000000001 |
| | 0000100000 | 00100000 | | | | |
| VAHINI | 0000000001 | 0000010000 | 0000010000 | 0000000100 | 0000100000 | 1001000001 |
| | 0001010000 | 0010100000 | 010010?000 | 0000000000 | 0000000100 | 0000000000 |
| | 0000000000 | 00100100 | | | | |
| VENTRI | 0000000001 | 0001010000 | 0000010000 | 0010000010 | 0000010000 | 00?1000000 |
| | 0?10010000 | 000?100000 | 0000010000 | 0000000000 | 0000010010 | 0000000000 |
| | 0001001000 | 00010001 | | | | |
| XARIFI | 1000001000 | 0000010000 | 0000010000 | 0100001000 | 0001000000 | 1000000010 |
| | 0010010000 | 0100000001 | 000100?000 | 0001000000 | 001100?000 | 0001000000 |
| | 1100?00000 | 01000101 | | | | |
| XENOCO | 0100?00000 | 0010000001 | 0000001000 | 0001000001 | 0000010000 | 0000000000 |
| | 0000110100 | 0000000000 | 000001?001 | 0000000000 | 000001?010 | 0000000000 |
| | 0001?01000 | 00010001 | | | | |

**Appendix 3.** List of synapomorphies for the 39 nodes (clades) in Figs. 7 and 8. Underlined figures indicate reversal.

| NODE | SYNAPOMORPHY | | | | | | | |
|------|------|------|------|------|------|------|------|------|
| 100 | 016 | 066 | | | | | | |
| 99 | 136 | | | | | | | |
| 98 | 106 | 124 | 127 | 134 | 138 | | | |
| 97 | 007 | <u>016</u> | 028 | 041 | <u>066</u> | | | |
| 96 | 001 | 007 | 037 | 132 | 136 | | | |
| 95 | 043 | <u>066</u> | 125 | | | | | |
| 94 | 032 | 037 | 071 | 080 | | | | |
| 93 | 027 | 034 | 109 | | | | | |
| 92 | 001 | 021 | 136 | | | | | |
| 91 | 026 | | | | | | | |
| 90 | 025 | 031 | 110 | | | | | |
| 89 | 017 | 022 | | | | | | |
| 88 | 014 | 039 | 053 | 054 | 062 | 063 | 074 | 075 |
| 87 | 002 | <u>016</u> | 065 | 068 | 086 | 090 | | |
| 86 | 132 | | | | | | | |
| 85 | 033 | | | | | | | |
| 84 | 063 | 084 | 104 | | | | | |
| 83 | <u>007</u> | 008 | 043 | <u>110</u> | 120 | | | |
| 82 | 036 | <u>037</u> | 042 | | | | | |
| 81 | 036 | 118 | | | | | | |
| 80 | 019 | 100 | 119 | | | | | |
| 79 | 040 | 046 | 107 | | | | | |
| 78 | 042 | | | | | | | |
| 77 | <u>007</u> | 053 | 055 | 064 | 074 | 076 | 085 | |
| 76 | 122 | | | | | | | |
| 75 | <u>007</u> | 008 | 031 | 124 | 127 | | | |
| 74 | <u>110</u> | | | | | | | |
| 73 | 029 | 091 | | | | | | |
| 72 | 008 | <u>022</u> | 023 | | | | | |
| 71 | 020 | 087 | | | | | | |
| 70 | <u>026</u> | 028 | <u>037</u> | | | | | |
| 69 | 017 | 043 | 069 | | | | | |
| 68 | 017 | | | | | | | |
| 67 | 057 | <u>100</u> | 111 | <u>125</u> | | | | |
| 66 | 005 | 014 | 023 | 054 | <u>132</u> | | | |
| 65 | <u>025</u> | 026 | | | | | | |
| 64 | 036 | 066 | 138 | | | | | |
| 63 | <u>028</u> | 064 | 133 | <u>136</u> | | | | |
| 62 | 005 | <u>119</u> | 123 | | | | | |